winters; in mild mid-winters the greatest variations of temperature usually occur in January. After a very mild winter, a warm summer is more probable than after a winter which is only moderately mild. Dr. Hellmann pleads for synoptic charts for the whole globe—at least for short intervals, if longer periods cannot be undertaken.

IN the *Journal of Botany* for April and May, Mr. A. Lister describes and figures some new or interesting species of Mycetozoa; Mr. E. A. N. Arber discusses the relationship to one another of the various forms of indefinite inflorescence; Mr. A. Gepp records the detection in Britain of a genus of Saprolegneous fungi, *Apodachlya;* Mr. G. S. West continues his account of the alga-flora of Cambridgeshire; Mr. F. S. Williams, his critical notes on species of *Cerastium;* and Mr. H. C. Hart, his account of a botanical excursion in Donegal.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 16.—"Experiments in Micro-metallurgy:—Effects of Strain. Preliminary Notice." By Prof. Ewing, F.R.S., and Walter Rosenhain, 1851 Exhibition Research Scholar, Melbourne University.

Much information has been obtained regarding the structure of metals by the methods of microscopic examination initiated by Sorby and successfully pursued by Andrews, Arnold, Charpy, Martens, Osmond, Roberts-Austen, Stead, and others. When a highly polished surface of metal is lightly etched and examined under the microscope, it reveals a structure which shows that the metal is made up in general of irregularly shaped grains with well-defined bounding surfaces. The exposed face of each grain has been found to consist of a multitude of crystal facets with a definite orientation. Seen under oblique illumination, these facets exhibit themselves by reflecting the light in a uniform manner over each single grain, but in very various manners over different grains, and, by changing the angle of incidence of the light, one or another grain is made to flash out comparatively brightly over its whole exposed surface, while others become dark.

The grains appear to be produced by crystallisation proceeding, more or less simultaneously, from as many centres or nuclei as there are grains, and the irregular more or less polygonal boundaries which are seen on a polished and etched surface result from the meeting of these crystal growths. The grains are, in fact, crystals, except that each of their bounding surfaces is casually determined by the meeting of one growth with another.

The experiments, of which this is a preliminary account, have been directed to examine the behaviour of the crystalline grains when the metal is subjected to strain.

For this purpose we have watched a polished surface under the microscope while the metal was gradually extended until it broke. By arranging a small straining machine on the stage of the microscope, we have been able to keep under continuous observation a particular group of crystalline grains while the piece was being stretched, and have obtained series of photographs showing the same group at various stages in the process. Strips of annealed sheet iron, sheet copper, and other metals have been examined in this way. We have also observed the effects of strain on the polished surfaces of bars in a 50-ton testing machine by means of a microscope hung from the bar itself, and have further observed the effects of compression and of torsion.

When a piece of iron or other metal exhibiting the usual granular structure is stretched beyond its elastic limit, a remarkable change occurs in the appearance of the polished and etched surface, as seen by the usual method of "vertical" illumination. A number of sharp black lines appear on the faces of the crystalline grains: at first they appear on a few grains only, and as the straining is continued they appear on more and more grains. On each grain they are more or less straight and parallel, but their directions are different on different grains. At first, just as the yield-point of the material is passed, the few lines which can be seen are for the most part transverse to the direction of the pull. As the stretch becomes greater oblique systems of lines on other grains come into view.

The photograph, Fig. 1, taken from a strip of transformer plate (rolled from Swedish iron and annealed after rolling), gives a characteristic view of these lines as they appear after a moderate amount of permanent stretching, but long before the iron has reached its breaking limit.

The appearance of each grain is so like that of a crevassed glacier, that these dark lines might readily be taken for cracks.

The real character of the lines is apparent when the crystalline constitution of each grain is considered. They are not cracks, but *slips* along planes of cleavage or gliding planes.

Fig. 2 is intended to represent a section through the upper part of two contiguous surface grains, having cleavage or gliding planes as indicated by the cross-hatching, AB being a portion of the polished surface. When the metal is pulled beyond its elastic limit, in the direction of the line A B, yielding takes place

FIG. 1.—Soft sheet iron strained by tension. 400 diameters.

by finite amounts of slips occurring at a limited number of places in the manner shown at *a*, *b*, *c*, *d*, *e* (Fig. 3). This slip exposes short portions of inclined surfaces, and when viewed under normally incident light, these surfaces appear black because they return no light to the microscope. They are consequently seen as dark lines or narrow bands, extending over the polished surface in directions which depend on the intersection of the polished surface with the surfaces of slip.

We have proved the correctness of this view by examining these bands under oblique light. When the light is incident at

Fig. 2. Before straining.

only a small angle to the polished surface, the surface appears for the most part dark; but here and there a system of the parallel bands shines out brilliantly in consequence of the short cleavage or gliding surfaces which constitute the bands having the proper inclination for reflecting the light into the microscope. Rotation of the stage to which the strained specimen is fixed makes the bands on one or another of the grains flash out successively, with kaleidoscopic effect. In what follows we shall speak of these lines as slip-bands. Fig. 1, through a mixed illumination, shows some of the slip-bands bright and some dark.

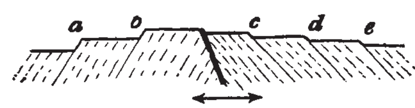

Fig. 3. After straining.

When the metal is much strained a second system of bands appears on some of the grains, crossing the first system at an angle, and in some cases showing little steps where the lines cross. These bands are clearly due to slips occurring in a second set of cleavage or gliding surfaces. Occasionally a third system of bands may be seen.

When the experiment is made with a polished but unetched specimen the slip-bands appear equally well. The boundaries of the grains are invisible before straining; but they can be distinguished as the strain proceeds, for the slip-bands form a cross-hatching which serves to mark out the surface of each grain.

Fig. 4 is another sample of iron strained by pull. The specimen in this case was a bar of Swedish iron, in which a comparatively large crystalline structure had been developed by annealing for some hours at 700° C. The photograph was taken after the bar had been broken in the testing machine, and shows with a magnification of 400 diameters a portion of the surface not far from the place of fracture.

The slip-bands are developed by compression as well as by extension. The bands developed by compression have apparently all the characteristics which they present in stretched pieces, and we could not, by microscopic examination of the surface, distinguish in this respect between the effects of compression and extension.

By twisting an iron bar well beyond the elastic limit the slip-bands are made to appear, for the most part, in directions parallel and perpendicular to the axis of twist.

A strip of sheet metal, such as iron or copper, in the soft state, when bent and unbent in the fingers, shows them well developed by the extension and compression of the surface.

These experiments throw what appears to us to be new light on the character of plastic strain in metals and other irregular crystalline aggregates. Plasticity is due to slip on the part of the crystals along cleavage or gliding surfaces. Each crystalline grain is deformed by numerous internal slips occurring at intervals throughout its mass. In general these slips no doubt occur in three planes, or possibly more, and the combination of the three allows the grain to accommodate itself to its envelope of neighbouring grains as the strain proceeds. The action is discontinuous: it is not a homogeneous shear but a series of finite slips, the portion of the crystal between one slip and the next behaving like a rigid solid. The process of slipping is one which takes time, and in this respect the aggregate effect is not easily distinguishable from the deformation of a viscous liquid.

We infer from the experiments that "flow" or non-elastic deformation in metals occurs through slip within each crystalline grain of portions of the crystal on one another along surfaces of cleavage or gliding surfaces. There is no need to suppose the portions which slip to be other than perfectly elastic. The slip, when it occurs, involves the expenditure of work in an irreversible manner.

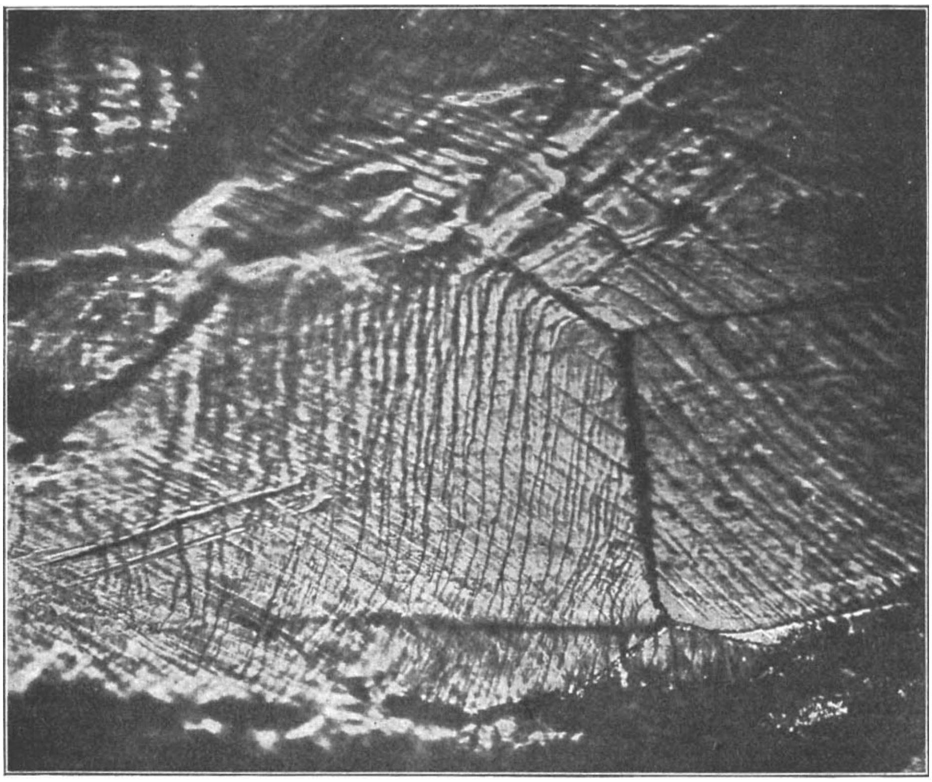

FIG. 4.—Swedish iron, much strained. 400 diameters.

It is because the metal is an aggregate of irregular crystals that it is plastic as a whole, and is able to be deformed in any manner as a result of the slips occurring in individual crystals. Plasticity requires that each portion should be able to change its shape and its position. Each crystalline grain changes its shape through slips occurring within itself, and its position through slips occurring in other grains.[1]

The experiments were made in the engineering laboratory at Cambridge, and are being continued. The authors express their indebtedness to Sir W. Roberts-Austen and Mr. T. Andrews for advice as to the preparation of specimens of metals for microscopic examination.

We have developed the slip-bands in iron, steel, copper, silver, gold, nickel, bismuth, tin, gun-metal, and brass. In gold and silver they show particularly well, the crystalline structure being large and the lines straight. In copper also the lines are straighter and more regularly spaced than is general in iron. Most of these metals have been tested in the form of blocks under compression. A beautiful development of slip-bands may readily be produced by pinching a button of polished silver or copper in a vice, or by bending a strip of sheet metal.

In carbon steels we have found the slip-bands considerably more difficult to observe than in wrought iron. The smaller granular structure of steel apparently makes the slip-bands correspondingly minute. In mild steel they are seen readily enough, but in a rather high carbon steel we succeeded in seeing them only with difficulty in the "ferrite" areas under a magnification of 1000 diameters. A cast piece of the nearly pure iron used for dynamo magnets showed a relatively very large granular structure and well marked slip-bands.

1 Attention should be called in this connection to the experiments of Messrs. McConnel and Kidd on the plasticity of glacier ice (*Roy. Soc. Proc.*, vol. xliv. p. 331). They found that bars cut from glacier ice which is an aggregate of irregular crystals are plastic.

April 27.—"On the Luminosity of the Rare Earths when heated in vacuo by means of Kathode Rays." By A. A. Campbell Swinton. Communicated to the Royal Society by Lord Kelvin, F.R.S.

For incandescent gas mantles it is found that certain definite mixtures of the rare earths are necessary in order to obtain the maximum luminosity. For instance, a mantle consisting of pure thoria or pure ceria will in the Bunsen flame only give about one-eleventh of the light of one composed of 99 per cent of thoria and 1 per cent of ceria, which is the mixture used by the Welsbach Company.

In order to explain this remarkable fact, several contradictory theories have been propounded, and with a view to elucidating matters the author has made experiments in which mantles composed of different pure oxides and mixtures were heated by kathode ray bombardment in vacuo.

The mantles were prepared according to the ordinary Welsbach process, and in order to obtain accurate comparisons the mantles were made in patchwork, each complete mantle being made up of two or four sections separately impregnated with different solutions. The mantles were so mounted in the vacuum tube that the kathode rays impinged equally upon the portions that consisted of different oxides and mixtures, so that an equal amount of energy was imparted to each sample. Under these conditions the Welsbach mixture of thoria plus 1 per cent. of ceria was found to give very little more light than pure thoria, the difference probably not exceeding 5 per cent., but on starting the kathode discharge the mixture heated up to incandescence more rapidly, and on stopping the discharge cooled more rapidly than the pure thoria. At the same time it was found that with an intensity of kathode rays that gave a brilliant light both with pure thoria and with the Welsbach mixture, a mixture of 50 per cent. thoria and 50 per cent. ceria, and also a piece of mantle composed of pure ceria, gave practically no light, becoming barely red-hot.

The maximum luminosities could only be obtained at a critical and highly unstable degree of vacuum, which rendered accurate photometrical measurements impossible, but with pure thoria the amount of light under favourable conditions was estimated at at least 150 candle-power per square inch of incandescent surface, this being obtained with an expenditure of electric energy at about 8000 volts pressure of approximately one Watt per candle.

The kathode rays were found to have a reducing action on the oxides, which became discoloured under the bombardment, the discoloration disappearing owing to re-oxidation on the admission of a small quantity of air. Air so admitted while the tube was working was rapidly absorbed, and after the process of admitting air and absorbing it had been repeated several times, the degree of exhaustion which gave the maximum incandescence was found to have altered considerably, the residual gas having apparently become less conducting.

In place of air, oxygen and hydrogen were separately used as the residual gas, but without any difference in the luminosity.

These experiments show that thoria and ceria, both alone and mixed, behave quite differently when heated by kathode ray bombardment than when heated in a Bunsen flame. In the latter thoria plus 1 per cent. of ceria gives many times as much light as pure thoria alone, while when incandesced by kathode rays of equal intensity the difference, though in a similar direction, is only just appreciable. Again, in the flame, pure ceria gives just about the same amount of light as pure thoria, while with a given intensity of kathode ray bombardment thoria gives a brilliant light, while ceria gives practically none. In arriving at any satisfactory theory of the luminescent properties of the rare earths, these results will have to be taken into account.

"A Quartz Thread Gravity Balance." By R. Threlfall and J. A. Pollock.

The balance is of the horizontal, stretched, quartz thread type. One end of the thread is attached by soldering to a spring of peculiar construction; the other end is attached to the axle of the vernier arm of a sextant. At the centre of the thread a bit of brass wire is attached by soldering, so that the thread crosses the wire, which is about two cm. long, at right angles. The centre of gravity of the bit of wire, which will be referred to as the "lever," lies a little to one side of the thread, so that when the thread is untwisted the lever hangs vertically. The thread is stretched so that, in spite of the weight of the lever, it hangs almost horizontally. To make this arrangement into a gravity balance, it is only necessary to turn the lever round the thread as axis, so that each half of the latter receives about three turns (3×360 degrees) of twist. The lever is adjusted till, under these circumstances, it hangs nearly horizontally. A discussion of the theory of the balance shows that if the twist be now reduced the centre of gravity of the lever will rise and the position of the lever become unstable soon after its centre of gravity rises above the horizontal plane through the thread. The nearly horizontal position of the lever is secured during observation by means of a microscope, which can be focussed upon the end of the lever, and which is rigidly attached to the framework of the instrument. Gravitational attraction on the lever is thus balanced by the torsional rigidity of the quartz fibre, and the observations consist in noting the increase or diminution of twist, as applied at one end of the thread, necessary to bring the lever to its sighted position. The whole apparatus is enclosed in a tube which is air-tight, the vernier axle working through a sort of mercury stuffing-box. Exact thermometry is required, and is supplied by means of a platinum thermometer lying alongside the thread.

The instrument only gives relative values of gravity, referring an excess, or defect, of gravitational force to the difference of gravitational intensity at two stations selected as having known constants, in the present case Sydney and Melbourne.

The difficulties which have been met with during many years' work arise from the warping of the metallic parts of the instrument under changes of temperature and in the imperfect elastic properties of fused quartz threads.

The possible errors of a single observation are shown, from a discussion of the detail of the instrument, to amount to about one part in 300,000 of the value of g at any point, and by a discussion of three journeys between Sydney and Hornsby (N.S.W.), it is shown that the consistency actually realised is about one in 500,000 of g.

Many journeys have been made with the instrument in New South Wales, Victoria, and Tasmania, from which the perfect portability of the instrument has been ascertained, as well as its convenience in practice. A single observation takes only a few minutes after the temperature has arrived at a maximum or minimum, but the packing and unpacking occupy more than an hour—in general about three hours are required. The weight of the total outfit, with ordinary appliances just as they came to hand in the laboratory, is 226 pounds, but this might be halved by making the appliances specially. The paper contains the complete theory of the instrument, working drawings exhibiting its construction, and an account of experiments made with various modifications of the instrument.

"On the Electrical Conductivity of Flames containing Salt Vapours." By Harold A. Wilson, B.Sc. (Lond. and Vic.), 1851 Exhibition Scholar. Communicated by Prof. J. J. Thomson, F.R.S.

The experiments described in this paper were undertaken with the object of following up the analogy between the conductivity of salt vapours and that of Röntgenised gases, and especially of getting some information about the velocities of the ions in the flame itself.

They are to some exent a continuation of the research of which an abstract has already been published in the *Proceedings* of the Royal Society ("The Electrical Conductivity and Luminosity of Flames containing Vaporised Salts," by A. Smithells, H. M. Dawson, and H. A. Wilson, *Roy. Soc. Proc.*, vol. lxiv. p. 142).

The paper is divided into the following sections:—

(1) Description of the apparatus for producing the flame.
(2) The relation between the current and E.M.F. in the flame.
(3) The fall of potential between the electrodes.
(4) The ionisation of the salt vapour.
(5) The relative velocities of the ions in the flame.
(6) The relative velocities of the ions in hot air.
(7) Conclusion.

The current with a large E.M.F. was found to be independent of the distance between the electrodes in the flame, provided both were hot enough to glow; it was much greater when the hotter electrode was negative than when it was positive. When both electrodes were hot, the fall of potential between them was found to be very like that observed in the discharge through gases at low pressure. If one of the electrodes was cool, then nearly all the fall of potential occurred very near to it. Practically all the ionisation of the salt vapours appeared to take place at

the surfaces of the glowing electrodes. The velocities of the ions in the flame were estimated by finding the electric intensity required to cause them to move down the flame against the upward stream of gases. The positive ions of all the alkali metal salts had a velocity of about 60 $\frac{\text{cms.}}{\text{sec.}}$ for one volt per cm. The corresponding velocity of the negative ions was about 1000 $\frac{\text{cms.}}{\text{sec.}}$ In a current of hot air the corresponding velocities were as follows:—

(1) Negative ions of salts of Li, Na, K, Rb, Cs, Ca, Sr, and Ba, 26·0 $\frac{\text{cms.}}{\text{sec.}}$

(2) Positive ions of salts of Li, Na, K, Rb, and Cs, 7·2 $\frac{\text{cms.}}{\text{sec.}}$

(3) Positive ions of salts of Ca, Sr, and Ba, 3·8 $\frac{\text{cms.}}{\text{sec.}}$

The greater velocity of the negative ions enables the phenomena of unipolar conduction &c., to be easily explained.

Physical Society, May 12.—Prof. Perry, Vice-President, in the chair.—Dr. Lehfeldt read a note on the vapour pressure of solutions of volatile substances. The change in vapour pressure of a solvent due to the solution in it of a small quantity of volatile material has been calculated on the basis of Raoult's rule for the corresponding case of a non-volatile dissolved body. The author has interpreted the formula of Nernst in the following words:—When a small quantity of volatile substance is dissolved in a liquid the vapour pressure of the liquid is altered in the ratio of the molecular fractional amount of solvent in the liquid to that in the vapour. In order to test this formula, it has been applied to the results of experiments made on four series of liquids, viz. alcohol with benzene and toluene, and carbon tetrachloride with benzene and toluene. In the case of normal solutions, such as carbon tetrachloride in toluene, carbon tetrachloride in benzene, and benzene in carbon tetrachloride, the agreement between the observed and calculated values of the percentage composition of the liquid was remarkably good. In the case of toluene in carbon tetrachloride the solution contained about 29 per cent. of the dissolved body; and as the range of applicability of the formula had probably been exceeded, the agreement was not so good as in the previous examples. The mixtures containing alcohol show maxima of vapour pressure, and on this account the departure from the formula is so much more marked that it is impossible to apply it except in the case of very dilute solutions. The temperature used throughout the experiments was 50° C.—The Secretary read a note by Prof. W. B. Morton and Dr. Barton on the discussion of their paper, on the criterion for an oscillatory discharge of a condenser. In the discussion which followed the reading of the paper, it was pointed out that the result obtained, viz. that on taking into account the distribution of the current in the wire—a condenser having the critical capacity on the simple theory gives an oscillatory discharge—seems to be contradicted by the well-known fact that the resistance of the wire is greater and the inductance less for oscillatory than for steady currents. *The explanation of the apparent paradox is to be found in the* effect of the damping on the inductance. When the damping is great and the frequency small, as in the neighbourhood of the critical case, what may be termed the equivalent inductance becomes greater than the steady current value. It is shown that this increase in "L" outweighs the increase of "R" in its effect upon the criterion for oscillatory discharge. An examination of the expression for the equivalent inductance in the case of iron shows that it is greater than the steady current value if the ratio of one amplitude to the next is greater than $e^{n/200}$ where n is the frequency of the oscillation. Since the decrease of "L" with maintained oscillations is due to a surface concentration of current, it is suggested that there must be an axial concentration in the case of damped vibrations. Following the method of Maxwell for determining the current density at a distance from the axis of a wire, an expression for the current was introduced containing a damping coefficient. The "quasi-amplitude" of the disturbance at any point in the wire was thus obtained. An examination of the result shows that making the damping zero indicates a surface concentration. If, on the other hand, the damping is great, the expression for the amplitude increases as the distance from the axis decreases, and we get an axial concentration. Assuming sufficient damping to produce this effect, it is shown that as we go through the point $r = \frac{a}{\sqrt{2}}$, where a is the radius of the wire, we pass from a greater value of current density in the inner parts to a less in the outer than would correspond to a uniform distribution throughout the wire. From general reasoning the authors think that if a rapidly damped disturbance is propagated into a wire from its boundary, and if the oscillations are slow enough to allow the current to penetrate to the core, we should expect to find an axial concentration in the latter stages of the phenomenon. Dr. Lehfeldt said that Prof. Lodge had pointed out, at the reading of the paper, that the solution the authors obtained changed character at the critical resistance. As this point had not been considered in the note, he supposed that the change in character made no difference to the results obtained. The Chairman expressed his interest in the proof of the existence of an axial concentration.—Mr. Addenbrooke exhibited and described a quadrant electrometer for application to alternating current measurements. The author has substituted for cylindrical quadrants two sets of flat plates, the top set being adjustable. In this way the range of the instrument is considerably increased. The ability to remove one or more of the top quadrants makes the needle very accessible. By lowering the needle on to the bottom quadrants, and then bringing down one of the top plates, the instrument can be carried with safety. One of the top quadrants can be worked up and down by a worm gear, and by this motion the "electrical zero" of the electrometer is obtained. The suspension consists of a flat phosphor bronze strip, the torsion of which is found to be perfectly uniform, there being no fatigue effect. The case of the instrument contains windows, so that the needle can be viewed from two directions at right angles, and there are screw motions to centre the needle with respect to the quadrants. To reduce the effect of air convection currents upon the needle, the inside of the case is lined with cotton velvet. The quadrants are supported on brass bars passing through long ebonite sleeves in the bottom of the instrument. This gives good insulation without the use of sulphuric acid, and there is no Leyden jar or condenser in connection with the needle. When using the electrometer idiostatically with the finest strip, a light needle, and the quadrants one-tenth of an inch apart, a difference of potential of one volt will produce a deflection of about 5 mms. upon a screen two metres distant. Using the instrument heterostatically with 100 volts on the needle one-fifth of an inch between the quadrants and half a volt acting across them a deflection of 200 mms. can be obtained. This sensitiveness is about twelve times as great as that got from instruments designed by Kelvin, Mascart, and Haga. Mr. Addenbrooke then showed how, in conjunction with a voltmeter and an ammeter, it was possible with his instrument to determine all the factors of an alternating current system. The increased sensitiveness of the electrometer renders it possible to measure currents of any magnitude with a very small waste of energy. Mr. Gaster pointed out that the measurement of self-induction with an electrometer could only be carried out practically if the current curve was a sine curve. He said that in curves obtained from a Ganz motor a correction amounting to 7 per cent. had to be applied. The Chairman said that even if the curve obtained was a sine curve, the electrometer was never used in this country for measuring self-induction. Prof. Herschel asked if it were possible to adjust the quadrants after the needle had been charged Mr. Addenbrooke then purposely disturbed the position of the adjustable plate, and, after charging the needle, reduced the deflection to zero by the worm gear. The author said that for high voltages the curve of calibration was different to that obtained from the ordinary formula. The Chairman said that this discrepancy was probably due to want of perfect symmetry. In a paper read before the Royal Society by Perry, Ayrton and Mather, it was shown that the presence of the guard around the mirror of an ordinary electrometer was sufficient to affect the needle when working with high voltages. In working with the plates very close together he was afraid the symmetry would be liable to be disturbed by a slight tilting of the needle due to electrostatic attraction. The author observed that the plates were only very close together when working with low voltages.

Chemical Society, May 4.—Prof. Thorpe, President, in the chair.—The following papers were read:—On the combustion of carbon disulphide, by H. B. Dixon and E. J. Russell. Carbon disulphide undergoes a phosphorescent combustion in air at temperatures below its ignition point, the lowest observed

value for which was 232°; prolonged heating of carbon disulphide at 230°, or prolonged exposure to bright light, causes slight decomposition. The decomposition of carbon bisulphide vapour by detonation is not propagated as an explosion, and no explosive wave could be propagated in mixtures of the vapour and oxygen containing less than 40 per cent. of the latter.—The action of nitric oxide on nitrogen peroxide, by H. B. Dixon and J. D. Peterkin. A very slight increase of volume occurs on mixing nitric oxide with nitrogen peroxide at 27°, but a considerable expansion attends the mixing of inert gases like nitrogen with the peroxide, owing to dissociation of the latter; these results may be explained by the equation

$$N_2O_3 \rightleftarrows NO + NO_2$$

on the supposition that at 27° the dissociation is nearly complete.—On the mode of burning of carbon, by H. B. Dixon. It is shown that Lang's view that carbon dioxide is the first product of the combustion of carbon, and that carbon monoxide is only produced by the subsequent reduction of the dioxide, is invalid.—Crystalline glycollic aldehyde, by H. J. H. Fenton and H. Jackson. The aqueous syrup containing glycollic aldehyde obtained by heating dihydroxymaleic acid with water, yields a hexose, $C_6H_{12}O_6$, on evaporation; during the latter process a small proportion of crystalline glycollic aldehyde sublimes; when first dissolved in water the aldehyde has the composition $C_4H_8O_4$, but after about twenty-four hours the molecular composition becomes $C_2H_4O_2$.—On the blue salt of Fehling's solution and other cuprotartrates, by O. Masson and B. D. Steele. The blue salt of Fehling's solution when dried *in vacuo* has the composition $K_3C_{12}H_9Cu_4O_{19}$, $4H_2O$, and contains a complex negative radicle of which copper is a part; none of the copper is electropositive.—The preparation of acid phenolic salts of dibasic acids, by S. B. Schryver. —The maximum pressure of naphthalene vapour, by R. W. Allen. The author has prepared, from new experimental data, tables showing the vapour pressure of naphthalene and giving the weight of naphthalene required to saturate a cubic metre of gas at temperatures ranging from 0° to 130°.—Scoparin, by A. G. Perkin. Scoparin, the colouring matter of broom, s probably a methoxyvitexin.—On a new compound of arsenic and tellurium, by E. C. Szarvasy and C. Messinger. The compounds of arsenic with elements of the oxygen-sulphur series which are most stable at high temperatures are As_2O_3, As_2S_2, As_2Se; since the differences between the molecular weights in this series of compounds are 15 and 16, it was thought probable that the compound As_8Te_3 should be formed at high temperatures. The authors have obtained this compound.—The action of hydrogen peroxide on secondary and tertiary aliphatic amines. Formation of alkylated hydroxylamines and oxamines, by W. R. Dunstan and E. Goulding.—The enantiomorphously related tetrahydroquinaldines, by W. J. Pope and S. J. Peachey. The authors have separated synthetic tetrahydroquinaldine into a dextro- and a lævo-rotatory isomeride by crystallising its salts with camphorsulphonic acids.

Entomological Society, May 3.—Mr. R. McLachlan, F.R.S., in the chair.—Dr. A. L. Bennett exhibited various insects which he had collected in the French Congo. They included a species of Mantidæ remarkable for its very striking resemblance in coloration to a piece of bark.—Mr. F. Enock exhibited a living specimen of *Nepa cinerea* infested with a number of minute red *Acari* on the ventral surface of the abdomen. He also showed eggs of *Nepa* and *Notonecta* lying *in situ* in decayed leaf-stalks of *Alisma*, and described the mode of oviposition as observed by himself in both of these genera. He then exhibited a living example of the remarkable aquatic Hymenopteron—*Prestwichia aquatica*, Lubb., and said it was one of a brood of nine, including eight ♀♀ and one ♂, that issued on May 1 from a single egg of *Colymbetes* found on September 5, 1898.—Mr. Merrifield showed some specimens of *Hemaris bombyliformis*, Esp., with the scales still covering the central portions of the wings. He said these scales, which are present immediately after the emergence of the insect but soon become detached, may be rendered adherent by allowing a very weak solution of indiarubber in benzoline to run over the wings. —Mr. C. H. Dolby-Tyler communicated a paper on the development of *Ceroplastes roseatus*, Towns. and Cockl.

Mathematical Society, May 11.—Prof. H. Lamb, F.R.S., Vice-President, in the chair.—Major MacMahon, R.A., F.R.S., communicated some results he has obtained in the theory of partitions.—Mr. H. M. Macdonald read a paper on the zeroes of aspherical harmonic, $P_n^m(\mu)$, considered as a function of n. —Mr. W. F. Sheppard gave an account of his paper on the statistical rejection of extreme variations, single or correlated (normal variation and normal correlation).

MANCHESTER.

Literary and Philosophical Society, April 25.—Mr. J. Cosmo Melvill, President, in the chair.—At this the annual general meeting, Mr. R. H. Inglis Palgrave, F.R.S., and Prof. William Ramsay, F.R.S., were elected honorary members of the Society.—The annual report (as amended) and the statement of accounts were adopted, and the following were elected officers and members of the Council for the ensuing year:—President, Prof. Horace Lamb, F.R.S.; vice-presidents, Prof. Osborne Reynolds, F.R.S., Mr. Charles Bailey, Mr. J. Cosmo Melvill, and Prof. W. Boyd Dawkins, F.R.S.; secretaries, Mr. R. F. Gwyther and Mr. Francis Jones; treasurer, Mr. J. J. Ashworth; librarian, Mr. W. E. Hoyle; other members of the Council, Prof. H. B. Dixon, F.R.S., Mr. Francis Nicholson, Mr. J. E. King, Mr. R. L. Taylor, Mr. F. J. Faraday, and Mr. W. H. Johnson.—At the ordinary meeting held afterwards, Prof. Dixon described an apparatus for bringing together nitrogen peroxide and nitric oxide in order to determine whether any combination occurs between the gases.

PARIS.

Academy of Sciences, May 8.—M. van Tieghem in the chair.—On the absolute measurement of time, deduced from the laws of universal attraction, by M. G. Lippmann. The unit of time suggested is based upon the proposition that the numerical value of the Newtonian constant is independent of the units of length and mass, and depends uniquely upon the choice of the unit of time. Inversely, the magnitude of the interval of time taken as unity is determined without ambiguity when the numerical value of the Newtonian constant which corresponds to it is given.—Anatomical and physiological characters of plants rendered artificially Alpine by alternation between extreme temperatures, by M. Gaston Bonnier. Alpine temperature conditions were imitated by keeping the plants in an ice box during the night, and exposing fully to the sun during the day. The petioles of the leaves develop more rapidly under these conditions, and the leaves, which are smaller and thicker, have a more highly developed layer of pallisade tissue, and frequently the reddish coloration of Alpine plants. The flowers are relatively larger and more highly coloured than those grown under ordinary conditions.—M. Prillieux was elected a member of the Botanical section, in place of the late M. Naudin.—On the circumstances which modify the images reflected by a mercury bath, and on the transmission through the soil of vibrations produced at the surface, by M. G. Bigourdan. In the hope of securing a steadier mercury surface, the bath was placed at varying distances from the surface of the earth. It was then found that two quite distinct classes of earth tremors could be distinguished, the one slow and regular, to which the name undulation is given, the other rapid and irregular vibrations.—On the pencils which correspond to the case where the series of Laplace is limited in one direction, by M. C. Guichard.—The groups of the order $p^2 q^2$, p being a number greater than q, by M. Le Vavasseur.—On the electric capacity of badly conducting bodies, by MM. I. I. Borgmann and A. A. Petrovsky.—On an intense source of monochromatic light, by MM. Ch. Fabry and A. Perot. The new source suggested is the electric arc between two surfaces of mercury *in vacuo*. The mercury is contained in two concentric glass tubes, the inner one only just separating the two mercury surfaces. On giving the tube a slight shock a momentary connection is set up, and the arc starts. For a perfectly stable arc a potential of about thirty volts is necessary, and a current of from two to three amperes. The light is not perfectly monochromatic, but may be easily rendered so by the interposition of cells containing suitable absorption media. Thus, a mixture of didymium chloride and potassium bichromate cuts off all rays except the green ray, the most useful ray for general purposes. —On the ratio of the atomic weights of hydrogen and oxygen, by M. A. Leduc. By taking into account the increase of pressure observed to take place when hydrogen and oxygen gases are mixed, the number for the ratios of the atomic weights deduced from the density of detonating

gas (15·898), is increased to 15·878, a number sensibly in agreement with the 15·88 found by the author by the gravimetric method.—On the increase of pressure produced by the mixture of two gases, and on the compressibility of the mixture, by M. Daniel Berthelot. The formulæ proposed by the author in a previous paper are applied to the gas mixtures, SO_2+CO_2, N_2+O_2, and H_2+O_2, and the results compared with the experiments of Sacerdote, Leduc, Rayleigh, and the author. The agreement is very close.—Researches on the separation of traces of bromine existing in chlorides, by M. H. Baubigny. A strong solution of the chloride, to which a large amount of copper sulphate has been added, is treated with potassium permanganate in the cold, and the whole reduced to dryness *in vacuo.* The whole of the bromine is thus given off, together with a little chlorine; the original method proposed by the author and M. Rivals is then applied to this mixture. Two test analyses show satisfactory results, even when only ·005 gram of bromide was present with 12 grams of chloride.—On the impurities of aluminium, by M. Adolphe Minet.—On magnesium phosphide, by M. Henri Gautier. The phosphide Mg_3P_2 was prepared in a pure state by the direct combination of the elements in a stream of hydrogen. Pure PH_3 is obtained on treating this with water.—On the flame of hydrogen, by MM. Schlagdenhauffen and Pagel. The violet-blue colour of a hydrogen flame obtained when the gas is prepared from zinc is not due to sulphur, as proposed by Salet, but selenium. Some selenium is invariably left behind in the residue, probably as lead selenide.—Hydrogenation of acetylene in presence of nickel, by MM. Paul Sabatier and J. B. Senderens. A mixture of hydrogen and acetylene acts vigorously upon reduced nickel, even in the cold, ethylene, ethane, and liquid hydrocarbons being produced in quantity.—On the dextrines arising from saccharification, by M. P. Petit.—Method for rapidly measuring the dimensions of small objects, independently of their distance. Application to pupillometry and to laryngometry. Illusion due to the muscular sense in the appreciation of the size of objects, by M. Th. Guilloz.—Pathological physiology of pregnancy, by MM. Charrin and Guillemonat.—The influence of freezing upon the development of the hen's egg, by M. Etienne Rabaud. The eggs were not killed by exposure to $-15°$ C., but the development was markedly affected, and that permanently.—Some remarks on the *Haementeria costata* of Müller, by M. A. Kowalevsky.—On the existence of a fauna of Arctic animals in the Charente at the Quaternary epoch, by MM. Marcellin Boule and Gustave Chauvet.—New researches on the caverns of Padirac, by MM. Armand Viré and Étienne Giraud.—On the ascent of the *Balaschoff* on March 24, by M. G. Le Cadet.

DIARY OF SOCIETIES.

THURSDAY, MAY 18.

ROYAL SOCIETY, at 4.30 —Bakerian Lecture: The Crystalline Structure of Metals: Prof. J. A. Ewing, F.R.S., and W. Rosenhain.—The Yellow Colouring Matters accompanying Chlorophyll and their Spectroscopic Relations: C. A. Schunck.—The Diffusion of Ions into Gases: J. S. Townsend.—The Diurnal Range of Rain at the Seven Observatories in connection with the Meteorological Office, 1871–1890: Dr. R. H. Scott, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electric Locomotives in Practice and Tractive Resistance in Tunnels, with Notes on Electric Locomotive Design: P. V. McMahon.

CHEMICAL SOCIETY, at 8.—Corydaline, Part VI.: Dr. J. J. Dobbie and A. Lauder.—Oxidation of Furfural by Hydrogen Peroxide: C. F. Cross, E. J. Bevan, and T. Freiberg.

FRIDAY, MAY 19.

ROYAL INSTITUTION, at 9.—Runic and Ogam Characters and Inscriptions in the British Isles: The Lord Bishop of Bristol.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—A Study of Enteric Fever in the Netherlands: Prof R. H. Saltet.

TUESDAY, MAY 23.

ROYAL INSTITUTION, at 3.—Recent Advances in Geology: Prof. W. J. Sollas, F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Corea: Mrs. Isabella Bishop.

WEDNESDAY, MAY 24.

GEOLOGICAL SOCIETY, at 8.—On the Distal End of a Mammalian Humerus from Tonbridge: Prof. H. G. Seeley, F.R.S.—On Evidence of a Bird from the Wealden Beds of Ansty Lane, near Cuckfield: Prof. H. G. Seeley, F.R.S.—On the Rhyolites of the Hauraki Goldfields (New Zealand): J. Park and F. Rutley.—On the Progressive Metamorphism of some "Dalradian" Sediments in the Region of Loch Awe: J. B. Hill.

THURSDAY, MAY 25.

ROYAL INSTITUTION, at 3.—Water Weeds: Prof. L. C. Miall F.R.S.

FRIDAY, MAY 26.

ROYAL INSTITUTION, at 9.—Climbs and Explorations in the Andes: Sir W. Martin Conway.

PHYSICAL SOCIETY, at 5.—On the Thermal Properties of Normal Pentane, Part 2: Prof. S. Young and Mr. Rose-Innes.—On the Distribution of Magnetic Induction in a Long Iron Bar: C. G. Lamb.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Cours Elémentaire de Zoologie: R. Perrier (Paris, Masson).—Chapters on the Natural History of the U.S.: Dr. R. W. Schufeldt (Gay).—Das Tierreich, 7 Liefg.: Profs. Canestrini and Kramer (Berlin, Friedländer).—Ditto, 8 Liefg.: Prof. K. Kraepelin (Berlin, Friedländer).—Electromagnetic Theory: O. Heaviside, Vol. 2 (*Electrician* Company).—The Tides Simply Explained: Rev. J. H. S. Moxly (Rivingtons).—A Manual of Surgical Treatment: Prof. W. W. Cheyne and Dr. F. F. Burghard, Part 1 (Longmans).—Physique et Chimie Viticoles: A. de Saporta (Paris, Carré and Naud).—The Aborigines of Tasmania: H. Ling Roth, 2nd edition (Halifax, King).

PAMPHLETS.—Die Elemente des Erdmagnetismus, &c.: Dr. H. Fritsche (St. Petersburg).—Man the Microcosm: L. Hall, Part 1 (Williams).—Die Lokalisation Morphogenetischer Vorgänge: H. Driesch (Leipzig, Engelmann).—Die Aufstellung der Tiere in Neuen Museum zu Darmstadt: G. von Koch (Leipzig, Engelmann).—Siebenter Jahres-Bericht des Sonnblick-Vereines für das Jahr 1898 (Wien).

SERIALS —Science Gossip, May (Strand).—Botanische Jahrbücher, Siebr. Bd. 1 and 2 Heft (Leipzig).—Fortnightly Review, May (Chapman).—Zeitschrift für Physikalische Chemie, xxviii. Band, 4 Heft (Leipzig).—Himmel und Erde, April (Berlin).—Natural Science, May (Pentland).—Journal of Botany, May (West).—Observatory, May (Taylor).—Journal of the Chemical Society, May (Gurney).—Geographical Journal, May (Stanford).—Monthly Weather Review, January (Washington).—Proceedings of the Royal Society of Edinburgh, Vol. xxii. pp. 361–440 (Edinburgh).—Engineering Magazine, May (Strand).—Physical Review, March (Macmillan).—Scientia, No. 3 (Paris, Carré).—Journal of Applied Microscopy, March (Rochester, N.Y.).—L'Anthropologie, Tome x. No. 2 (Paris).—Record of Technical and Secondary Education, April (Macmillan).—Memoirs of the Boston Society of Natural History, Vol. v. Nos. 4 and 5 (Boston, Mass.).—American Journal of Mathematics, April (Baltimore).—Psychological Review, May (Macmillan).—National Geographic Magazine, May (Washington).—American Journal of Science, May (New Haven).—Botanischer Jahrbücher, Sechsr. Band, v. Heft (Leipzig).

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